



## Defining Postsecondary Expectations for Mathematics in Kentucky

As recommended in the American Diploma Project (ADP) legal research report, the ADP asked members of the postsecondary community in Kentucky to define their expectations of high school graduates (related to admissions and placement decisions), to comment on what is now expected of high school students for graduation in the commonwealth, and to identify the gaps that may exist between those different sets of expectations. The ADP's gap-analysis work consists of two parts. **Part one** focused on an analysis of the content of high school exit and college entrance/placement assessments; **part two** focused on defining postsecondary expectations and determining the degree to which current ADP state standards and assessments reflect those expectations.

In **part one**, the Education Trust assembled English Language Arts (ELA) and mathematics faculty members from K-12 systems and from two- and four-year colleges in the five ADP partner states (Indiana, Kentucky, Massachusetts, Nevada, and Texas). At these meetings, the faculty members examined the content of partner-state high school graduation assessments, national college admissions and placement tests (i.e., SAT, ACT, COMPASS, Accuplacer), a sampling of postsecondary institutional placement tests, and the GED.

The results from part one comprise Education Trust's five state reports, reflecting the feedback received from faculty members to the aforementioned assessments, as well as the Education Trust's analytical "cross-state" report. These reports discuss the relative strengths and weaknesses of the assessments and how well each assessment might serve postsecondary institutions in making admissions and placement decisions. By examining individual test items, the faculty members were able to examine the breadth and depth of content coverage, as well as the types and quality of test items.<sup>1</sup>

The first part of the gap-analysis work revealed that although the Kentucky Core Content Test (KCCT) of Mathematics is administered in grade 11, the reviewers stated that the assessment could not work as a diagnostic of progress towards college readiness unless a significant number of Algebra II items were added to the assessment.

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<sup>1</sup> The Education Trust gap-analysis reports were circulated in 2002 and are available on the ADP website <<http://www.americandiplomaproject.org/>>.

A closer look at the alignment of the Kentucky Core Content Tests to the Kentucky Core Content for Assessment Standards and faculty expectations was warranted to determine how high school standards and assessments might become more closely aligned to college admissions and placement standards.

In **part two**, Achieve and ADP staff, using an assessment-to-standards alignment protocol developed by Achieve, conducted an alignment study of the Kentucky Core Content for Assessment standards and the Kentucky Core Content Test (KCCT) of Reading (10<sup>th</sup> grade), Mathematics (11<sup>th</sup> grade), and (on-demand) Writing (12<sup>th</sup> grade). With both the assessment-content analysis and the alignment studies complete, ADP staff met with faculty members from two- and four-year colleges in Kentucky, representing a range of content areas (organized into ELA and Math Teams) to:

1. define their expectations for incoming students,
2. prioritize their expectations for students, as may be contained in the Kentucky Content Standards,
3. determine the degree to which the current standards and assessments together reflect those expectations, and
4. identify any gaps (missing content) in the standards and assessments.

In this round of discussion, it was particularly helpful to have had a cross-section of faculty from the humanities, sciences and social sciences, since reading, writing and mathematics skills are necessary for success in all credit-bearing courses throughout college, not just English and mathematics.

## *Part One Findings (Mathematics): Assessment Content Analysis*

- KCCT of Mathematics is administered in the 11<sup>th</sup> grade and as such, the reviewers stated that the assessment could work as a diagnostic of progress towards college readiness, and even for admissions and placement at the postsecondary level, provided Algebra II gained substantially more prominence on the assessment and other adjustments were made to the assessment.
- The Kentucky Early Mathematics Testing Program (KEMTP) is a voluntary diagnostic assessment taken over the Internet to assess the readiness of high school sophomores and juniors for college mathematics. The KEMTP is predominantly an assessment of algebra (60 percent of questions pertain to Algebra I and II). Consistent with college mathematics curricula, the KEMTP focuses less on geometry and statistics than does the KCCT of Mathematics. The KEMTP is a selected-response assessment – unlike the KCCT of Mathematics that includes six constructed-response items highly valued by the postsecondary professors -- and is overwhelmingly procedural. At present, a small but growing number of students take the KEMTP.
- Like the KEMTP, the Eastern Kentucky University and Western Kentucky University mathematics placement tests almost exclusively assess students' mastery of algebra (the Western Kentucky assessment more so than the Eastern Kentucky assessment). Consequently, the KEMTP and the two reviewed placement tests lack the geometry, statistics, and number-sense coverage of the KCCT of Mathematics. The reviewers stated that the college placement tests, with such limited scope and depth, should not be used in isolation to place students appropriately in college courses. The placement tests ought to be used in conjunction with some other assessment to compensate for these shortcomings. At present, colleges supplement the placement tests with ACT or SAT I scores to make placement decisions.
- Although not as heavily weighted towards algebra as the aforementioned placement tests, both the SAT I and the ACT are predominantly assessments of Algebra I (with very little Algebra II). The SAT I and the ACT also contain many items at the middle school level: 40 percent of the items in the case of the former and one third in the case of the latter. The strengths of the SAT I are its emphasis on symbolic representations and students' reasoning abilities, as well as its inclusion of more problem-solving items than the KCCT or the multiple-choice placement tests. The reviewers did state that a number of KCCT items are more thought-provoking than those on the ACT.<sup>2</sup>

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<sup>2</sup> For further reflection on this issue, see the Question Four discussion below.

## *Part Two Findings (Mathematics): Definition of Postsecondary Expectations and Examination of Alignment among Standards, Assessments and Expectations*

Part two of the postsecondary-expectations analysis began by Achieve, Inc. and ADP staff conducting an assessment-to-standards alignment study of the KCCT of Mathematics and the Kentucky Core Content for Mathematics Assessment Standards. The alignment protocol used was designed by Achieve to determine the extent to which standards-based assessments actually assess the content standards that a state has defined for students. Following is a brief description of the Achieve protocol.<sup>3</sup>

The protocol considers four dimensions in its analysis of the degree of alignment between an assessment and a set of standards.

- **Content centrality:** This criterion provides a deeper analysis of the match between the content of each examination question and the content of the related standard by examining the degree or quality of the match. Reviewers assign each item to one of four categories based on the degree of alignment: “2” = clearly consistent; “1a” = not specific enough; “1b” = somewhat consistent; “0” = inconsistent.
- **Performance centrality:** This criterion focuses on the degree of the match between the type of performance (cognitive demand) presented by each examination item and the type of performance described by the related standard. Each item makes a certain type of cognitive demand on a student (e.g., the item requires a certain performance such as “select,” “identify,” “compare,” or “analyze”). Reviewers assign each item to one of four categories based on the degree of alignment: “2” = clearly consistent; “1a” = not specific enough; “1b” = somewhat consistent; “0” = inconsistent.
- **Challenge:** This criterion is applied to a set of items to determine whether doing well on these items requires students to master challenging subject matter. Reviewers consider two factors in evaluating sets of examination items against the challenge criterion: *source* of challenge and *level* of challenge.
  - **Source of challenge** attempts to uncover whether the individual examination items in a set are difficult because of the knowledge and skills they target, or because of other reasons not related to the subject matter, such as relying unfairly on students’ background knowledge. Reviewers rate each item as having an appropriate (1) or inappropriate (0) source of challenge.
  - **Level of challenge** compares the emphasis of performance required by a set of items to the emphasis of performance described by the related standard.

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<sup>3</sup> A complete description of the Achieve protocol, “Benchmarking and Alignment of Standards and Testing, CSE Technical Report,” is available on the ADP website <<http://www.americandiplomaproject.org/>>.

In addition to evaluating alignment, reviewers also judge whether the set of examination items has a span of difficulty appropriate for students at a given grade level based on the standards, the assessment and supporting materials. Reviewers assign each item to one of four categories indicating its type of cognitive demand: 4 = extended thinking; 3 = strategic thinking; 2 = skill/concept; 1 = recall.

- **Balance and range:** No one assessment can measure the full range of knowledge and skills described in the state standards. Evaluating balance and range provides both qualitative and quantitative descriptive information about the choices states or test developers have made.
  - **Balance** compares the emphasis of content supplied by an item set to the emphasis of content described by the standards. In addition to evaluating alignment, reviewers also judge whether the set of items emphasizes the more important content at the grade level. Reviewers write a succinct summary of the balance of each item set.
  - **Range** is a measure of coverage or breadth (the numerical proportion of all content addressed).

With the alignment study complete (*see appendices below for summary data for each of the above categories*), ADP staff met with faculty members from two- and four-year colleges in Kentucky, representing a range of content areas, for the following discussion.

### **Step One: Define Expectations for Incoming Students**

Thinking more about what is actually needed, rather than bowing to the current state of student mathematics expertise, what follows is a list of minimum competencies/concepts articulated by the Kentucky Math Team for students entering **College**

#### **Algebra:**

1. Basic arithmetic
  - a. Real number computation WITHOUT the use of a calculator (see below for a discussion of calculator use on the KCCT)
  - b. Fractions, decimals, percentages, ratios, proportions
  - c. Long division
  - d. Exponents, square roots, and scientific notation
  - e. Dimensional analysis
  - f. Properties of whole, real, and rational numbers (primes, divisibility)
  - g. Different base systems (binary system)
  - h. Order of magnitude understanding/reasonableness of answers
  - i. Metric system
2. Algebra I & Algebra II
  - a. Linear equations (solve and check)

- b. Literal equations (solve and check)
- c. Linear inequalities (solve and check)
- d. Systems of linear equations (2 equations by 2 variables)
- e. Graphing of linear equations and sketching graphs of parabolas, circles
- f. Interpreting linear graphs and understanding slope and intercepts
- g. Concept of functions in terms of tables, graphs, symbolically and in words; domain and range
- h. Concept of linear functions and quadratic functions
- i. Awareness of nonlinear functions
- j. Exponents, the exponent rule, rational exponents
- k. Operations of polynomials including factoring
- l. Basic quadratic equations by factoring and by graphing
- m. Operations of polynomials including some factoring
- 3. Geometry
  - a. Basic area, volume, and perimeter formulas for plane or solid quadrilaterals (including to write a formula and explain what it means)
  - b. Basic geometric properties and principles (perpendicularity, parallelism, similarity)
  - c. Intellectual process of proofs/analytical reasoning skills
  - d. Basic trigonometry (Right triangle and Pythagorean Theorem)
- 4. Probability and Statistics
  - a. Construction and interpretation of graphs
- 5. Conceptual Understanding
  - a. Ability to generalize (transfer understanding in one area to another)
  - b. Pattern recognition
  - c. Logical reasoning
  - d. Solving word problems that have application to the students' real worlds
  - e. Recognize insufficient or irrelevant information in problems

Thinking more about what is actually needed, rather than bowing to the current state of student mathematics expertise, what follows is a list of minimum competencies/ concepts (above and beyond those listed above) articulated by the Kentucky Math Team for students entering **Calculus (e.g., math, science and engineering majors)**:

- 1. Algebra
  - a. Linear and nonlinear functions (polynomial, rational, trigonometric, exponential and logarithmic functions) and interrelationships between these functions (the inverses)
  - b. Manipulation, representation, simplification and graphing of equations of all kinds
  - c. Maximum, minimum, slope
  - d. Right triangle trigonometry, trigonometric identities, trigonometric equations.
  - e. Systems of linear inequalities (solve and check)
  - f. Quadratic and rational inequalities (solve and check)
  - g. Trigonometric functions (polar coordinates) (solve and check)

- h. Linear regression, understanding what the output means
  - i. Absolute value equations and piecewise defined functions (graph and solve)
  - j. Manipulation and notation of functions and the algebraic steps to solve them
2. Geometry
- a. Exposure to mathematical proof by induction

### **Step Two: Prioritize expectations for students, as reflected in the Kentucky Core Content for Mathematics Assessment standards**

**Question One:** Are the competencies required for college-level work in a broad range of disciplines represented in the Kentucky Core Content for Mathematics Assessment standards?

**Answer:** The Math Team concluded that the Kentucky mathematics Core Content standards and objectives are comprehensive and contain most of the content that represents college readiness for *non-math-dependent* fields.

Following are some suggestions to further strengthen the standards.

- According to the Math Team, the Kentucky Core Content for Mathematics Assessment standards have several content gaps. The standards do not require students to perform important skills such as dimensional analysis, understanding different bases of number systems, developing proofs, translating between the metric and customary systems of measurement, and understanding formulas (beyond simply applying them).
- The current organization (concepts vs. skills vs. relationships) of the Kentucky Core Content for Mathematics Assessment standards caused some confusion for team members. In some cases, reviewers observed that there are no significant differences separating the three sections: “Concepts,” “Skills,” and “Relationships.” In other cases, team members had trouble agreeing on what a particular statement meant. Adding examples that exemplify what is meant by each objective (along with tighter connection with the assessment items) would allow for greater clarity of the standards themselves.
- The Math Team felt that neither the standards nor the KCCT of Mathematics adequately cover what students need to know to be prepared for *math majors* or *math-dependent* fields in college.
- The Math Team felt that the standards should designate when a student is expected to perform calculations without a calculator. For example, “Students will perform addition, subtraction, multiplication, and division with real

numbers in problem-solving situations to specified accuracy,” WITHOUT a calculator would satisfy the team members.

**Step Three: Determine the degree to which the Kentucky Core Content Test of mathematics reflects the Kentucky Core Content for Mathematics Assessment standards and postsecondary expectations**

**Question Two:** How does the standards balance/emphasis of the KCCT of Mathematics compare to the emphasis that the Math Team places on the mathematics knowledge and skills needed to begin college-level work?

**Question Three:** Can the KCCT of Mathematics be used in its current form for postsecondary admissions and/or placement?

**Question Four:** What other suggestions do you have for improving the assessment beyond those discussed above?

**Question Five:** What other recommendations does the Math Team have for the Kentucky P-16 Council regarding issues surrounding the administration of the KCCT of Mathematics?

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**Question Two:** How does the standards balance/emphasis of the KCCT of Mathematics compare to the emphasis that the Math Team places on the mathematics knowledge and skills needed to begin college-level work?

**Answer:** The balance/emphasis of the standards in the mathematics assessments is not closely aligned to college expectations. In some key areas the KCCT would need to be adjusted in order to increase the usefulness of the assessment for postsecondary admission and/or placement decisions (see *TABLE MATH1*).

TABLE MATH1: Standards Emphasis/Balance on KCCT of Mathematics<sup>4</sup>

<b>Standards</b>	<b>KY Math Team Recommendations (College Algebra)</b>	<b>KY Math Team Recommendations (Calculus)</b>	<b>KCCT of Mathematics</b>
STANDARD 1: Number/Computation Concepts, Skills, and Relationships.	34.2%	23.0%	26.7%
STANDARD 2: Geometry/Masurement Concepts, Skills, and Relationships.	18.3%	27.0%	30.0%
STANDARD 3: Probability/Statistics Concepts, Skills, and Relationships.	12.5%	4.0%	26.7%

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<sup>4</sup> The Achieve alignment study did not precisely reflect Kentucky’s assessment blueprint: the alignment study revealed that 16.6% of the test was dedicated to algebraic ideas whereas the blueprint identified 35% of the test as dedicated to algebraic ideas. Likewise, the alignment study identified 26.7% of the test as dedicated to probability and statistics as opposed to the blueprint’s notation of only 15% of the test dedicated to the same.



Standards	KY Math Team Recommendations (College Algebra)	KY Math Team Recommendations (Calculus)	KCCT of Mathematics
STANDARD 4: Algebraic Ideas Concepts, Skills, and Relationships.	35.0%	46.0%	16.6%
<b>TOTALS</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>

- Across the board, the Math Team would like *significantly more emphasis on algebraic ideas, concepts, skills, and relationships* as algebra is a prerequisite for most college-level mathematics courses. Specifically, the Math Team would like the KCCT to dedicate more than twice the current percentage to algebra for students entering a college algebra course and nearly three times the current percentage of the assessment to algebra for students entering a college calculus course. (Math-dependent majors – science, engineering, finance – are required to take calculus.). As it stands, only three of nineteen (15.7 percent) high school algebra objectives are assessed.
- Several important areas are under-assessed or not assessed, including:
  - Solving linear equations/inequalities
  - Graphing linear equations
  - Solving systems of linear equation
  - Knowing and applying functional concepts such as domain, range, slope, intercepts, roles of independent and dependent variables
  - Factoring polynomial expressions
  - Performing operations on polynomial expressions
  - Determining approximate solutions to quadratic equations
  - Using direct and inverse variation
  - Modeling how changes in parameters affect graphs of functions.
- At the same time, the team recommends substantially reducing the percentage of the assessment dedicated to probability and statistics for students entering college algebra, and reducing it even further for students entering college calculus.<sup>5</sup> There was, however, a dissenting view: the professor of sociology who participated on the Math Team defended the current heavy emphasis on statistics because familiarity with statistics – from high school – would be useful to students taking sociology and psychology courses, as well as many other science courses.

**Question Three:** Can the KCCT of Mathematics be used in its current form for postsecondary admissions and/or placement?

**Answer:** No. Placing all other concerns aside (discussed below), the KCCTs are matrix tests and are designed to measure school achievement rather than individual student achievement. As such, they cannot generate individual student scores. Until Kentucky moves to an assessment that provides individual student

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<sup>5</sup> The team was quick to point out that probability and statistics concepts are important life-skills for students to understand generally.

scores, as federal law now requires at grades three through eight and at one grade in high school, the results cannot be useful for postsecondary admissions and placement decisions.

- The Achieve alignment study<sup>6</sup> revealed that only 43.3 percent of the test items on the KCCT of Mathematics were found to be clearly consistent with the content in the standards. The remaining items (56.7 percent) received a “1b”, meaning that they were aligned to only part of a standard, often to the lesser part (see *TABLE MATH2*).
- In addition, only 46.7 percent of items received “2s” for performance centrality, while 26.7 percent received a “1b” (measured the performance in part). Unfortunately, 16.6 percent received a “1a”, indicating that the performance demanded in the standards was too unclear to determine a match, and the final 10 percent received a “0”, indicating that the performance demanded on the assessment failed to match the performance demanded in the standards (see *TABLE MATH2*).

TABLE MATH2: Content & Performance Centrality of KCCT of Mathematics

Centrality	# of Items	<b>2</b> (clearly consistent)	<b>1a</b> (standard not specific enough)	<b>1b</b> (item assesses only a part of the standard)	<b>0</b> (inconsistent)
Content	30 (100% of test)	43.3% of all items received a 2	No items received a 1a	56.7% of all items received a 1b	No items received a 0
Performance	30 (100% of test)	46.7% of all items received a 2	16.6% of all items received a 1a	26.7% of all items received a 1b	10% of all items received a 0

- The Math Team stated that the most important objectives (for postsecondary admissions/placement purposes) are under-assessed on the KCCT of Mathematics in favor of the less-/least-important objectives. Only five of the 22 objectives the team identified as vital or very important (team rated “2.5” out of “3” or better) are assessed, while fourteen less essential objectives are. Thus, the KCCT of Mathematics is not, in its current form, aligned closely enough to postsecondary expectations to be useful.<sup>7</sup>
- The team cited Algebra II content as the most important content in terms of college admissions and placement. With so little algebra assessed on the KCCT of Mathematics and so much of it of low cognitive demand, the KCCT is inadequate to assess students’ college readiness for credit bearing algebra.

<sup>6</sup> See appendices for the Achieve study summary data.

<sup>7</sup> It is important to remember that the KCCT is a matrix assessment; the team reviewed only one of six forms. It is possible that in combination, the six forms would adequately test the vital content contained within the standards.

- With its heavy emphasis on statistics, however, the KCCT may be adequate to assess students' ability to handle the statistics they may encounter in, for example, sociology courses.
- With regard to the level of cognitive demand on the KCCT of Mathematics, 90 percent of the test items were rated a level "2" or below; about one quarter received a "1" or basic comprehension (see *TABLE MATH3*).

TABLE MATH3: Level of Cognitive Demand

<b>Demand</b> (28 items scored)	<b>4</b> (extended thinking)	<b>3</b> (strategic thinking)	<b>2</b> (skill/concept)	<b>1</b> (recall)
	No items received a 4	10% of all items received a 3	66.7% of all items received a 2	23.3% of all items received a 1

- Only four of 12 high school objectives in number/computations are assessed. Important areas not assessed (as defined by the vital minimum postsecondary competencies/concepts listed above) include
  - Properties of real number system
  - Performing operations on real numbers
- Likewise only six of 16 geometry/measurement objectives are assessed. Important areas not assessed (as defined by the vital minimum postsecondary competencies/concepts listed above) include
  - Ratio measures such as slope, indirect measurement
  - Algebraic/geometric relationships

**Question Four:** What other suggestions do you have for improving the assessment beyond those discussed above?

**Answer:** The Math Team made several recommendations:

- The Math Team recommends that calculator use be restricted to sections of the assessment that contain more complex, challenging, thought-provoking, reasoning/problem-solving items and not be allowed for sections of the assessment that contain items that are meant to assess basic computation skills. Calculator use could, for instance, be limited to the six constructed-response items contained on the KCCT.
- The Math Team also recommends that formula sheets likewise be restricted or limited. Some team members who had participated in the Education Trust review (Part 1) mentioned that had they had the Formula sheet in Austin, they would not have determined the assessment to be as "thought-provoking" as they had. For example, a trigonometry question becomes a simple computation question with the access to trigonometric formulas on the Formula sheet. The Math Team suggested that partitioning the assessment, just as with calculators, would resolve this problem.

The inappropriate use of calculators and formula-sheets can render an assessment a measure of a student's ability to use a calculator or read a formula sheet rather than an assessment of the skill described in the standard or objective.

- The Math Team would also like to see more short-answer items that would require students to develop answers on their own, rather than to simply select the right answer among several provided. Likewise, the team would also welcome an increase in the number of constructed-response items that would require students to demonstrate their understanding of the mathematics and reasoning involved.<sup>8</sup>
- The Math Team was critical of the accompanying scoring guide because it is silent about the required levels of mastery of *mathematics* content and skills. The team concluded that the scoring guide seems to suggest that students could raise their scores without demonstrating increased mathematics competency. A scoring guide that makes mathematical competency the central focus would be more sensible and send a more appropriate message about the assessment's central requirement that students demonstrate proficiency in mathematics.
- As the commonwealth works to revamp its assessment system to meet the directives in the new federal legislation, *No Child Left Behind*, the team expressed its preference for the commonwealth to supplement the KCCT of Mathematics with end-of-course mathematics assessments in Algebra I, Geometry, and Algebra II. End-of-course assessments would allow for more in-depth coverage of the content area and would be more readily useable than the current KCCT of Mathematics for postsecondary admissions and placement decisions.
- In a similar vein, some members of the Math Team familiar with the Kentucky Early Mathematics Testing Program (KEMTP), wondered whether the diagnostic might be used in some way to supplement the KCCT of Mathematics. KEMTP was designed to assess student readiness for college mathematics and in particular for college algebra. Some changes in the administration of the KEMTP would be necessary, and the team felt that some sort of incentive should be offered to students who choose to take the extra time and effort to take such an assessment.

**Question Five:** What other recommendations does the Math Team have for the Kentucky P-16 Council regarding issues surrounding the administration of the KCCT of Mathematics?

**Answer:**

- Once individual scores on the KCCT are generated, they ought to be reported on students' transcripts by standard (i.e., algebra, geometry, number sense, probability/statistics). That would give colleges more information than they currently receive from an ACT score. Placing scores on transcripts would also provide an

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<sup>8</sup> The KCCT already includes some constructed-response items, a distinct advantage over the current Kentucky college placement assessments in use.

incentive to students to do their very best on the KCCT (as would a policy that required students to pass the KCCT in order to graduate).

- The team recommends that the commonwealth improve the lag time between the administration of the KCCT in the spring of grade 11 and when scores are available. At present, scores often aren't available until well into the fall of students' senior year.
- Regarding a recommended mathematics course sequence:
  - The Math Team recommends that students take at a minimum the traditional sequence of Algebra I, (formal) Geometry, Algebra II. In addition, students would be advised to take a fourth year of mathematics (a rigorous, substantive course) in order to maximize their readiness for credit-bearing work in college. College-bound students lose too much math competency if they fail to take a substantive mathematics course their senior year. College-level mathematical competency is best guaranteed by continuous and recent mathematics study, but at present, the commonwealth requires just 3 credits in mathematics and names only Algebra I and Geometry as requirements, leaving the third course option up to students.<sup>9</sup>
  - As was the case in the other partner states, members of the Kentucky Math Team stressed the importance of mastering Algebra I, Geometry, and Algebra II rather than being exposed to a superficial treatment of Calculus in high school. They equated a strong, solid foundation in Algebra I, Geometry, and Algebra II with the ability of high school graduates to begin credit-bearing college coursework upon entrance, and argued that having taken a nominal Calculus course at the expense of such a foundation would undermine that preparation.

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<sup>9</sup> This underscores the recommendation of the P-16 Council.

# APPENDICES

The following tables represent the results from the Achieve alignment study for the Kentucky KCCT of Mathematics (11<sup>th</sup> grade) and the Kentucky Content Standards.

## **Assessment**

Kentucky Core Content Test:  
*Grade 11 Mathematics, Spring 1999 Release Form*

## **Standards**

Kentucky Core Content for Mathematics Assessment  
*Grades 9 through 11 with Assessment at Grade 11*  
*Version 3.0, August 1999*

## **Test Design**

24 multiple-choice items  
6 open-response items  
30 items scored\*

*\* Scoring includes the eight items mapped to objectives  
in the Core Content Standards for Grades 6-8.*

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## **APPENDIX 1: Content Centrality**

## **APPENDIX 2: Performance Centrality**

## **APPENDIX 3: Source of Challenge**

## **APPENDIX 4: Level of Cognitive Demand**

## **APPENDIX 5: Level Of Challenge**

## **APPENDIX 6: Range**

## **APPENDIX 7: Balance**

## APPENDIX 1: Content Centrality

Note: Ratings for Content Centrality are "2" = clearly consistent; "1a" = not specific enough; "1b" = somewhat consistent; "0" = inconsistent.

Standard	# of Items	2	1a	1b	0
Number/Computation	8 (26.7%)	3	1	3	1
Geometry/Masurement	9 (30%)	5	2	2	0
Probability/Statistics	8 (26.7%)	3	1	3	1
Algebraic Ideas	5 (16.6%)	3	1	0	1
<b>TEST AS A WHOLE</b>	<b>30</b> (100%)	<b>14</b> (46.7%)	<b>5</b> (16.6%)	<b>8</b> (26.7%)	<b>3</b> (10%)

## APPENDIX 2: Performance Centrality

Note: Ratings for Performance Centrality are "2" = clearly consistent; "1a" = not specific enough; "1b" = somewhat consistent; "0" = inconsistent.

Standard	# of Items	2	1a	1b	0
Number/Computation	8 (26.7%)	3	1	3	1
Geometry/Masurement	9 (30%)	5	2	2	0
Probability/Statistics	8 (26.7%)	3	1	3	1
Algebraic Ideas	5 (16.6%)	3	1	0	1
<b>TEST AS A WHOLE</b>	<b>30</b> (100%)	<b>14</b> (46.7%)	<b>5</b> (16.6%)	<b>8</b> (26.7%)	<b>3</b> (10%)

## APPENDIX 3: Source of Challenge

Note: Ratings for Source of Challenge are "1" = appropriate, "0" = inappropriate.

Standard	# of Items	1	0	Not Scored
Number/Computation	8 (26.7%)	6	2	0
Geometry/Masurement	9 (30%)	9	0	0
Probability/Statistics	8 (26.7%)	8	0	0
Algebraic Ideas	5 (16.6%)	5	0	0
<b>TEST AS A WHOLE</b>	<b>30</b> (100%)	<b>28</b> (93.3%)	<b>2</b> (6.7%)	<b>0</b>

## APPENDIX 4: Level of Cognitive Demand

*Note: Ratings for Level of Cognitive Demand are “4” = extended thinking; “3” = strategic thinking; “2” = skill/concept; “1” = recall.*

Standard	# of Items	2	1a	1b	0
Number/Computation	8 (26.7%)	0	1	6	1
Geometry/Masurement	9 (30%)	0	1	6	2
Probability/Statistics	8 (26.7%)	0	0	5	3
Algebraic Ideas	5 (16.6%)	0	1	3	1
<b>TEST AS A WHOLE</b>	<b>30</b> (100%)	0	3 (10%)	20 (66.7%)	7 (23.3%)

## APPENDIX 5: Level Of Challenge

*Note: Ratings for Level of Challenge are either Appropriate or Low.*

Standard	Level of Challenge of Item Set	Comments
Number/Computation	Appropriate	MC=6, OR=2 Level 1=1, Level 2=6, Level 3=1 3 MC items map to Core Content for Grades 6-8
Geometry/Masurement	Appropriate	MC=7, OR=2 Level 1=2, Level 2=6, Level 3=1 1 MC item maps to Core Content for Grades 6-8
Probability/Statistics	Low	MC=7, OR=1 Level 1=3, Level 2=5 4 MC items map to Core Content for Grades 6-8
Algebraic Ideas	Low	MC=4, OR=1 Level 1=1, Level 2=3, Level 3=1
<b>TEST AS A WHOLE</b>	<b>Low</b>	MC=24, OR=6 Level 1=7, Level 2=20, Level 3=3



## APPENDIX 6: Range

*Note: Ratings for Range are either Good, Acceptable, or Poor.*

Standard	Portion of Standards Assessed	Range of Item Set
Number/Computation	4/12 or 0.33	Poor
Geometry/Masurement	6/16 or 0.38	Poor
Probability/Statistics	4/15 or 0.27	Poor
Algebraic Ideas	3/19 or 0.16	Poor
<b>TEST AS A WHOLE</b>	<b>17/62 or 0.27</b>	<b>Poor</b>

## APPENDIX 7: Balance

*Note: Ratings for Balance are either Fair or Poor.*

Standard	Balance of Item Set	Comments
Number/ Computation	Poor	Two items map to one objective, and 3 items map to middle school objectives. With only 4 of 12 high school objectives being assessed by 8 items, balance is affected. Areas not assessed include properties of real numbers, equivalence and order relations, subsets of the real number system and matrices and matrix operations. It is sometimes the case that not all aspects of the content and/or performance within a given objective are assessed. The set of items mapping to this high school standard does not adequately reflect the content emphasized in the standard.
Geometry/ Measurement	Poor	Two objectives have 2 items mapped to them, and one item maps to a middle school objective. With only 6 of 16 high school objectives assessed by 9 items, balance is impacted. Areas not assessed, or inadequately assessed, include line relationships, angle relationships, ratio measures such as slope, indirect measurement, surface area, calculation of midpoints, and algebraic/geometric relationships. It is sometimes the case that not all aspects of an objective are assessed. The set of items mapping to this high school standard does not adequately reflect the content emphasized in the standard.

Standard	Balance of Item Set	Comments
Probability/ Statistics	Poor	Half of the 8 items mapping to this standard align with middle school objectives. With only 4 of 15 high school objectives being assessed by 8 items, balance is affected. Areas not assessed, or inadequately assessed, include standard deviation and the impact of outliers on measures of central tendency; organizing, displaying, and interpreting data; using data to make decisions or predict; calculating probabilities involving replacement and non-replacement; and recognizing the appropriate versus inappropriate use of statistics and graphical representations. The set of items mapping to this high school standard does not adequately reflect the content emphasized in the standard.
Algebraic Ideas	Poor	Although only 5 items align with this standard, 3 of them align to one objective. With only 3 of 19 high school objectives being assessed by 5 items, balance is an issue. Areas not assessed, or under-assessed, include solving linear equations/inequalities; graphing linear equations; solving systems of linear equation; knowing and applying functional concepts such as domain, range, slope, intercepts; factoring polynomial expressions; performing operations on polynomial expressions; determining approximate solutions to quadratic equations; using direct and inverse variation; and modeling how changes in parameters affect graphs of functions. It is sometimes the case that not all aspects of the content and/or performance within a given objective are assessed. The set of items mapping to this high school standard does not adequately reflect the content emphasized in the standard.
<b>TEST AS A WHOLE</b>	<b>Poor</b>	This test form alone does not reflect the balance defined by Kentucky's blueprint (Number/Computation: 20%, Geometry/Masurement: 30%, Probability/Statistics: 15%, and Algebraic Ideas: 35%). In particular, this test over-emphasizes probability and statistics (albeit at a low level) and under-emphasizes algebra.